EUROPEAN AIRPORT MOVEMENT MANAGEMENT BY A-SMGCS, Part 2

EMMA2 Operational Concept for a complete A-SMGCS

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Integrated Project of the
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Priority 1.4:
Aeronautics and Space,
sponsored by EC, DG TREN
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Background

- EMMA aimed to prepare a complete concept of an A-SMGCS that will be the focus of research in EMMA2
- Difficulties with existing ICAO, EUOCONTROL, and EUROCAE levels of implementation when describing new services:
  - Less care for technical enablers and procedures
  - No evolutionary steps with ICAO requirments
  - Currently, 4 A-SMGCS levels
    - But with routing, guidance, and onboard services the system gets more complex (there are more than 2 evolution levels III & IV)
    - 4 A-SMGCS functions can hardly be matched to the services received by ATCOs, Pilots, and Vehicles Drivers

Definition of Services proposed by EMMA

- Service Description is allocated to the user who receives it and not to a primary function
- 3 main users:
  - **ATCOs** receive
    - Surveillance
    - Routing
    - Control
    - *Guidance (ground based guidance) service*
  - **Pilots** receive onboard services enabled by A-SMGCS
  - **Vehicle Drivers** receive onboard services

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EMMA Approach

- 4 Work Shops with 16 Partners from
  - **Industry** (Airbus, PAS, TATM, SELEX)
  - **R&D** (DLR, NLR, EUROCONTROL)
  - **Users**
    - ANSPs (ANS_CR, AENA, DSNA, ENAV, DFS)
    - Airlines (DLH, CSA)
    - Airports (CSL, AENA)

- D131u EMMA OSED-update Document (public very soon)

Technical Enablers

- When defining a service, **their technical enablers** have to be regarded
- It is an iterative process
  - Service ⟷ technical Enablers

Functions and Technical Enablers

ATCO – Surveillance Service

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Function	On-board Enabler	Ground Enabler
Provide traffic information	•Mode S transponder •ADS-out	•Cooperative sensors (SSR, Mode-S, ADS-B, GNSS) •Non-cooperative sensors (SMR) •Sensor data fusion •Flight information •Vehicle information
Provide traffic context		•Aeronautical info server •Meteo data
Interface with ATCOs		•HMI component

Service Steps of Implementation

- Different **steps of implementation** for each individual service that depends on following criteria:

  (1) Development status of the technical enabler (standardised, on the market or to be developed yet)

  (2) Development status of the service (already validated or only at the stage of a concept)

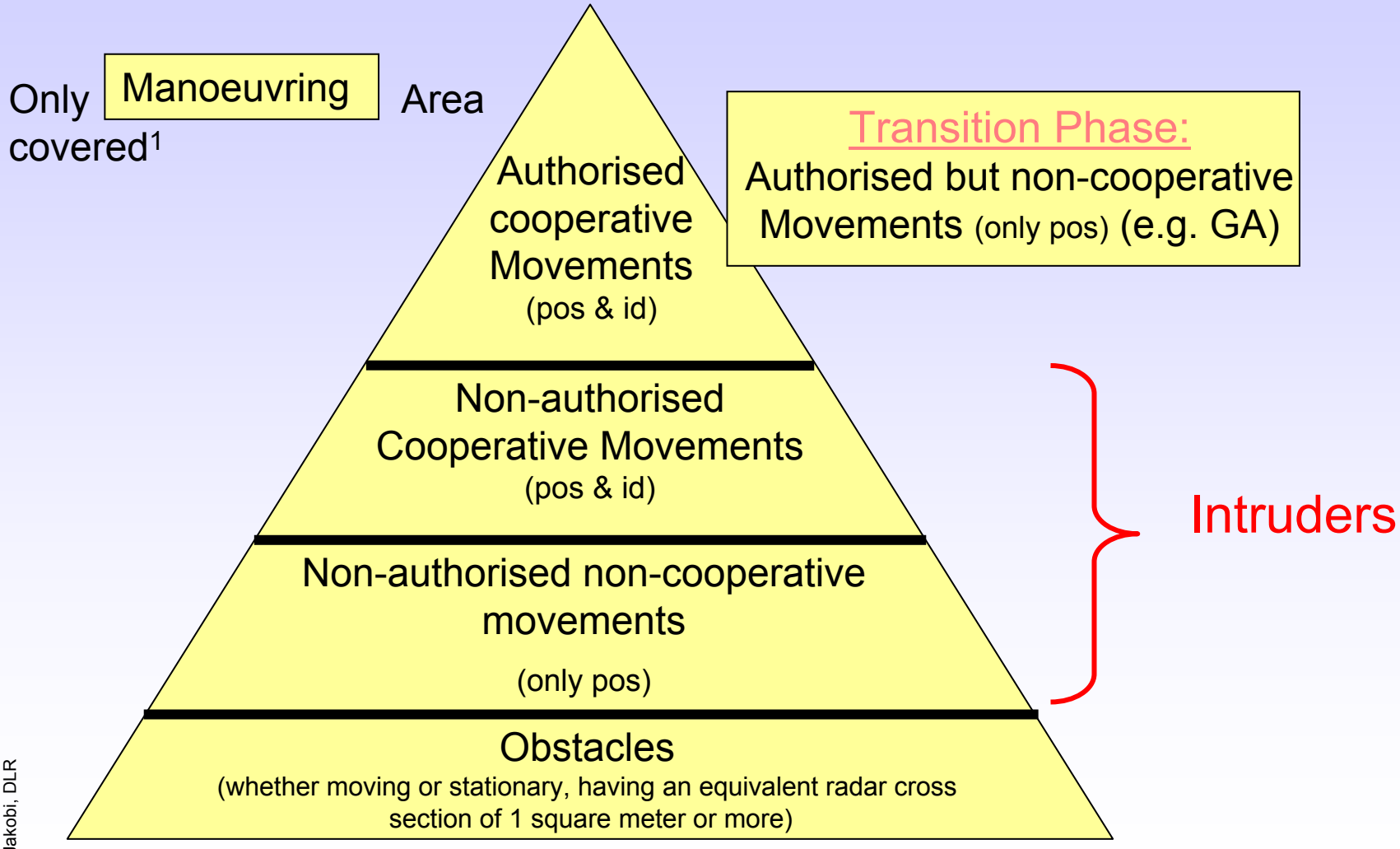
  (3) Degree of interrelations to other functions (complexity)

  (4) Quality of the enabling equipment (needed reliability, safety)

  (5) Impact on current operational procedures and size of the changes

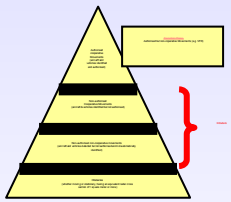
  (6) Cost/benefit considerations

Services Steps
ATCO Surveillance – Service Step 1



Services Steps
ATCO Surveillance – Service Step 2

Manoeuvering + Apron area



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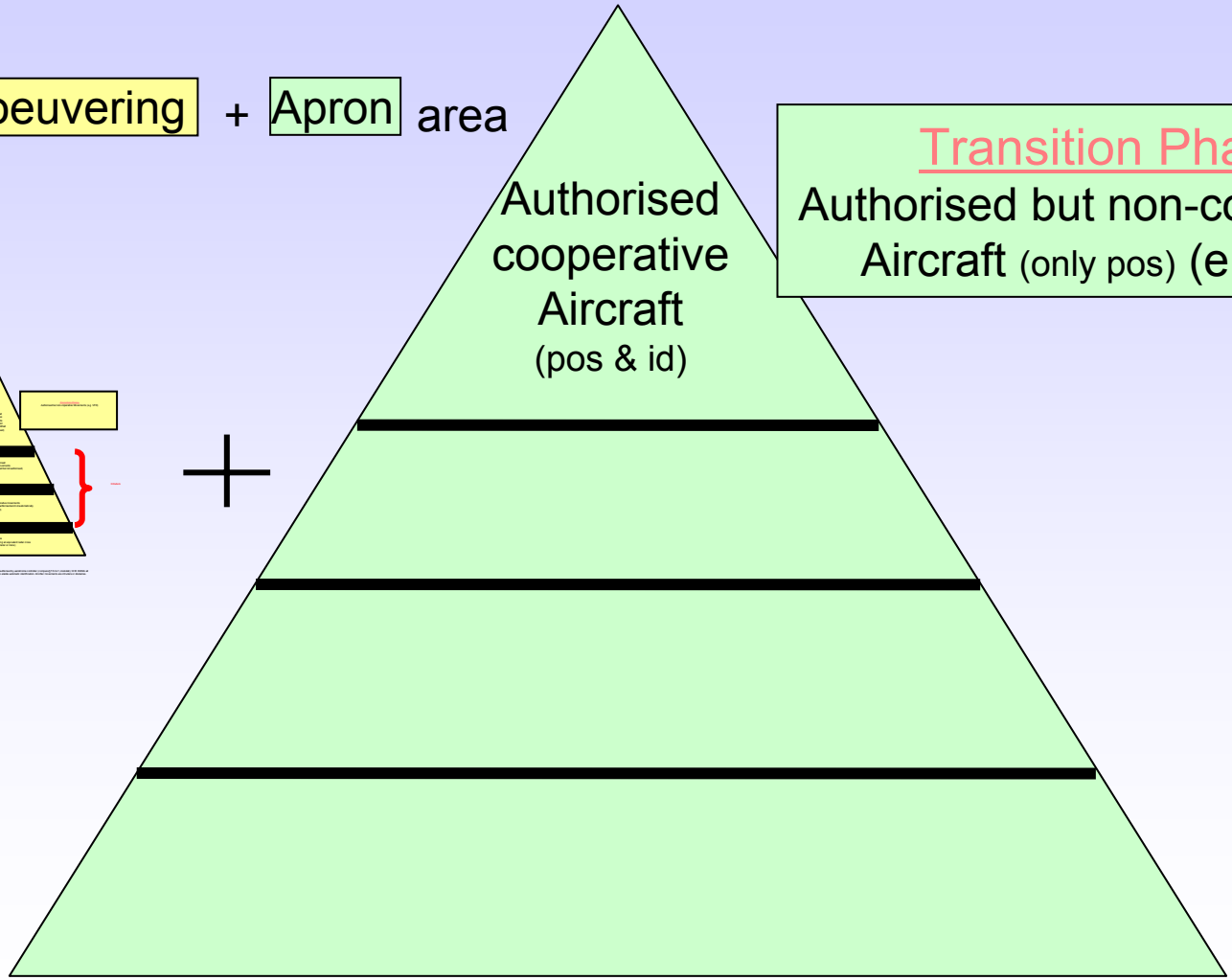
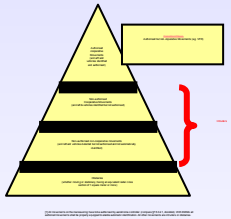


Transition Phase:
Authorised but non-cooperative Aircraft (only pos) (e.g. GA)

Services Steps
ATCO Surveillance – Service Step 3 (+VIS3)

Manoeuvering + Apron area



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Authorised cooperative Aircraft
(pos & id)

Authorised Cooperative Vehicles[2]
((pos & id)
within designated areas where vehicles can conflict with aircraft

Non-authorised Vehicles[2]

Obstacles
(whether moving or stationary, having an equivalent radar cross section of 1 square meter or more within designated area where obstacles can conflict aircraft movements [taxi lanes, active stands])

Transition Phase:
Authorised but non-cooperative Aircraft (e.g. GA)

Intruder

[2] In low visibility conditions, when movements are not able to avoid each other, parts of the apron area (taxi lanes, active stands) are used exclusively for authorised movements. In LVO Vehicles operating in these areas must be authorised and equipped. In good visibility conditions vehicles do not have to be controlled on the Apron (compare also ICAO doc 9830 §3.5.16.3).

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Services Steps
ATCO - Surveillance

Service Steps	Description	Comments
Step 1	• Detection and accurate position of all aircraft, all vehicles, and obstacles • Identification of all cooperative aircraft and vehicles	Manoeuvring area
Step 2	• Step1 + Detection and identification of **all aircrafts**	Movement area (incl. Apron)
Step 3	• Step2 + • Detection and identification of **all vehicles** • Detection of **Obstacles**	Movement area (incl. Apron) •Vis3 - where manoeuvring a/c may come into conflict with each other or with vehicles ICAO doc 9830 §3.5.16.3

Functions and Technical Enablers

ATCO - Control

Function	On-board Enabler	Ground Enabler
Conflict and Incursion Detection and Alerting		•Surveillance function + alerting algorithm
Conflict Resolution		•Resolution algorithm
Support to Communication	•Data Link (point to point) •Onboard HMI component	•Data Link •Ground HMI component
Support to coordination between ATCOs		•Flight Data Management •Electronic Flight Strips

Service Steps
ATCO - Control

Service Step	Description	Comments
Step 1	•**Runway** Conflict/Incursion detection and alerting	Implementation of **conflict resolution** advisory may be initiated at any step
Step 2	•**Taxiway** Conflict/Incursion detection and alerting	
Step 3	•Detection of plan / **route deviation** •Support to Communication (**CPDLC**) •ATCO coordination (**EFS**)	
Step 4	•Conflict/Incursion detection and alerting of **apron / stand / gate** conflicts	

Functions and Technical Enablers

ATCO - Routing

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Function	On-board Enabler	Ground Enabler
Manual Routing	None	•Input Devices + •simple routing algorithm
Semi-automatic Routing	None	•Routing algorithm + •Interfaces to external data
Automatic Routing	None	•Routing algorithm + •Interfaces to external data •Planning algorithm (SU-time, DMAN)

Service Steps
ATCO - Routing

Service Steps	Description	Comments
Step 1	Manual Routing	Manual input of a route supported by the shortest taxi route w.r.t. to local standard routes
Step 2	Semi-automatic Routing	Routing service proposes a most suitable route, taking into account control and flight plan information.
Step 3	Automatic Routing	Routing service provides route (track) and time information by aid of a planning function.
Step 4		

Service Steps
ATCO – Routing

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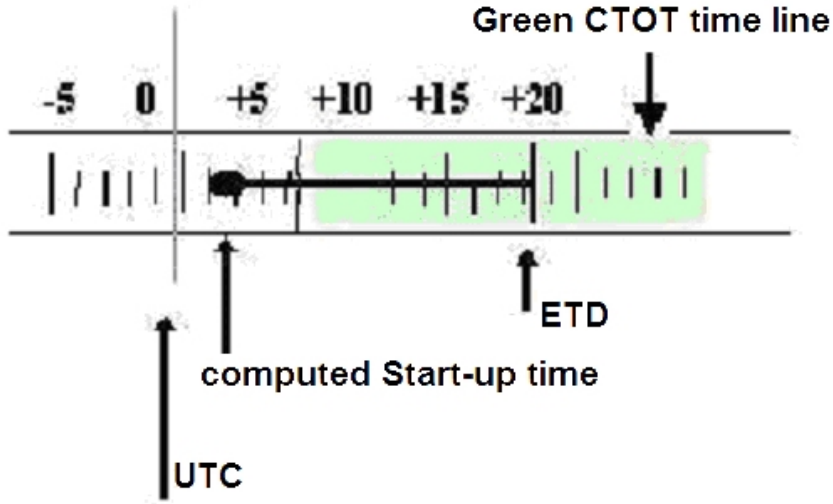
Efficient taxi route + Start-up time

EFS Active Departure

CALLSIGN	STAND	CTOT	EOBT	ACTYPE/W	DEST	RWY	SID	SSR	ALERT	TAXI ROUTE	REMARK	STATUS	CLR	-5	0	5	10	15	20
CSA978	N20	1910	1904	AT72/M	LZKZ	24	RATIS	0336		J-H-B		▶	=						



Source: BETA

Service Steps
ATCO - Routing

Service Steps	Description	Comments
Step 1	Manual Routing	Manual input of a route supported by the shortest taxi route w.r.t. to local standard routes
Step 2	Semi-automatic Routing	Routing service proposes a most suitable route, taking into account control and flight plan information.
Step 3	Automatic Routing	Routing service provides route (track) and time information by aid of a planning function.
Step 4	Automatic Routing + ROP (DMAN)[1]	Planning support is further increased by a departure manager providing optimal runway occupancy times.

Services Steps
ATCO – Ground Guidance

Service Steps	Description	Comments
Step 1	Manual Operation of Ground based Guidance Means	Equipment available on the market.
Step 2	Automatic Operation of Ground based Guidance Means	Automatic generation of guidance information, based on the cleared route and the actual position of the aircraft.

Functions and Technical Enablers

Pilot (Flight Crew)

Function 1/2	On-board Enabler	Ground Enabler
Airport Moving Map	•Own-ship position and state vector •Aeronautical database (airport layout)	
Surface Movement Alerting	•AMM •Conflict and Alerting algorithm	
Ground Traffic Display	•ADS-B-in •AMM	•TIS-B (to see non ADS-B aircraft, vehicles)
Traffic Conflict Detection	•Conflict and Alerting algorithm	•TIS-B
Ground / Air Database Upload	•Aeronautical database	•Airport Mapping Database server •X-NOTAM •D-ATIS

Functions and Technical Enablers

Pilot (Flight Crew)

Function 2/2	On-board Enabler	Ground Enabler
CPDLC Ground Clearances and Taxi Route Uplink	•CPDLC (DCL, D-Taxi) •Airport Moving Map	•CPDLC •Routing function
Braking and Steering Cues	•Taxi-Route (uplinked or not) •Aeronautical database (airport layout) •B&S algorithm	
HUD Surface Guidance	•Taxi Route (uplinked or not) •Own-ship position and state vector •Aeronautical database	
Automated Steering	•Taxi Route (uplinked or not) •Own-ship position and state vector •Auto-Pilot for taxiing	

Service Steps
Pilot (Flight Crew)

Service Steps	Description	Comments
Step 1	•Airport Moving Map •Surface Movement Alerting •Braking and Steering Cue (for landing roll)	•Equipment already available
Step 2	•Ground-Air Database Upload •Ground Traffic Display •Traffic Conflict Detection •CPDLC Ground Clearance and Taxi Route Uplink •Braking and Steering Cue (landing roll and taxi)	•Ground TIS-B + DL needed
Step 3	•HUD Surface Guidance	•HUD is already available for approach
Step 4	•Automated Steering	•Major changes in equipments and procedures

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Services Steps
Vehicle Drivers

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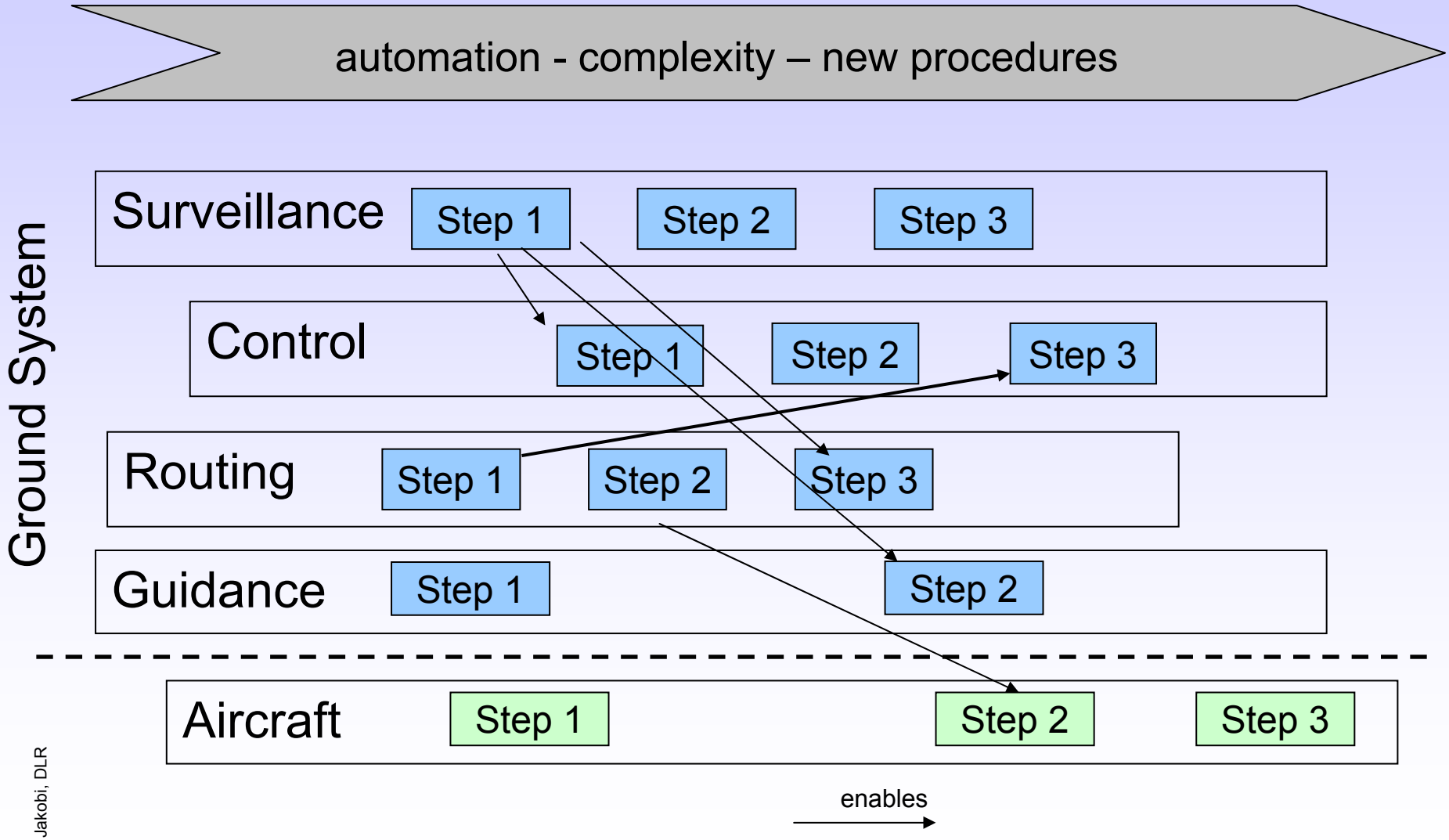
Service Steps	Description	Comments
Step 1	•Airport Moving Map inlc. alerts	•No ground equipment •Equipment already available
Step 2	•Ground-Air Database Upload •Ground Traffic Display incl. alerts	•Ground TIS-B + DL needed
Step 3	•Dispatch and Guidance via data link	

Definition of Procedures

- Procedures are the core to enable a service to bring benefit
- Workshop with Users to discuss by which potential procedures the services should be applied
- Procedures defined for higher services but still very pre-matured
- But we need initial procedures to test new services in validation activities (EMMA2)
- Initial procedures used to cluster service steps to **A-SMGCS implementation packages**

Logical Interdependencies between EMMA Service Steps



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Logical Interdependencies between EMMA Service Steps

DLR

	Expected Steps to each Service											
Surveillance	**S1** id/pos everything manoeuvering			**S2** Step 1 + id/pos a/c in the movement area						**S3** S2 + id/pos vehicles movement area		
Control	**C1** Conflict Rwy			**C2** Conflict Twy			**C3** Plan / Route Deviation				**C4** Conflict Apron	
Guidance	**G1** Manual switched ground guidance (e.g. Heathrow)									**G2** Auto switch		
Routing				**R1** Manual			**R2** Semi-auto			**R3** Auto (planning)		**R4** ROP
Aircraft		**A1** AMM					**A2** Ground traffic + CPDLC			**A3** HUD	**A4** Auto steering	
Vehicles		**V1** AMM					**V2** Ground Traffic			**V3** Data link		

ICAO A-SMGCS Categorisation

1. Visibility Conditions
   - Vis 1 no impact
   - Vis 2 ATCO cannot see
   - Vis 3 Pilots cannot see and avoid (400m < Vis 3 < 75m)
   - Vis 4 Pilots cannot taxi (< 75m)

2. Traffic Density
   - Light (L): 0 < movements < 20
   - Medium (M): 20 < movements < 35
   - Heavy (H): 35 < movements ∞

3. Aerodrome Layout
   - Basic (B): = 1 RWY = 1 TWY = 1 Apron
   - Simple (S): = 1 RWY > 1 TWY ≥ 1 Apron
   - Complex (C): > 1 RWY > 1 TWY ≥ 1 Apron

ICAO implementation levels

Aerodrome Types	User	Surveillance	Control			Routing	Guidance					Level
			Conflict Prediction and/or Detection	Conflict Analysis	Conflict Resolution		Ground 1*	Ground 2*	Ground 3*	Ground 4*	On Board	
T-1: 1:(B)(L) T-2: 1:(B)(M) T-3: 1:(B)(H) T-4: 1:(S)(L)	Controller	X	X	X	X	X						I
	Pilot/Vehicle driver						X					
	System											
T-5: 1:(S)(M) T-6: 1:(S)(H) T-7: 1:(C)(L) T-10: 2:(B)(L) T-11: 2:(B)(M) T-13: 2:(S)(L)	Controller	X	X	X	X	X						II
	Pilot/Vehicle driver		X	X	X		X	X				
	System	X	X									
T-8: 1:(C)(M) T-12: 2:(B)(H) T-14: 2:(S)(M) T-16: 2:(C)(L) T-19: 3:(B)(L) T-20: 3:(B)(M) T-22: 3:(S)(L)	Controller		X	X	X				X			III
	Pilot/Vehicle driver		X	X[1)]	X[1)]		X					
	System	X	X	X	X	X						
T-9: 1:(C)(H) T-15: 2:(S)(H) T-17: 2:(C)(M) T-18: 2:(C)(H) T-21: 3:(B)(H) T-23: 3:(S)(M) T-24: 3:(S)(H) T-25: 3:(C)(L) T-26: 3:(C)(M) T-27: 3:(C)(H)	Controller		X	X	X							IV
	Pilot/Vehicle driver		X	X[1)]	X[1)]		X					
	System	X	X	X	X	X				X		
T-28: 4:(B)(L) T-29: 4:(B)(M) T-30: 4:(B)(H) T-31: 4:(S)(L) T-32: 4:(S)(M) T-33: 4:(S)(H) T-34: 4:(C)(L) T-35: 4:(C)(M) T-36: 4:(C)(H)	Controller		X	X	X							V
	Pilot/Vehicle driver						X				X	
	System	X	X	X	X	X				X		

SMGCS

ICAO A-SMGCS Categorisation T1 – T36

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Visibility conditions			
1	2	3	4
T-1: (B)(L)	T-10: (B)(L)	T-19: (B)(L)	T-28: (B)(L)
T-2: (B)(M)	T-11: (B)(M)	T-20: (B)(M)	T-29: (B)(M)
T-3: (B)(H)	T-12: (B)(H)	T-21: (B)(H)	T-30: (B)(H)
T-4: (S)(L)	T-13: (S)(L)	T-22: (S)(L)	T-31: (S)(L)
T-5: (S)(M)	T-14: (S)(M)	T-23: (S)(M)	T-32: (S)(M)
T-6: (S)(H)	T-15: (S)(H)	T-24: (S)(H)	T-33: (S)(H)
T-7: (C)(L)	T-16: (C)(L)	T-25: (C)(L)	T-34: (C)(L)
T-8: (C)(M)	T-17: (C)(M)	T-26: (C)(M)	T-35: (C)(M)
T-9: (C)(H)	T-18: (C)(H)	T-27: (C)(H)	T-36: (C)(H)

Level I

Level II

Level III

Level IV

Level V

ICAO A-SMGCS Categorisation T1 – T36 + EMMA View

Visibility conditions			
1	2	3	4
T-1: (B)(L)	T-10: (B)(L)	T-19: (B)(L)	T-28: (B)(L)
T-2: (B)(M)	T-11: (B)(M)	T-20: (B)(M)	T-29: (B)(M)
T-3: (B)(H)	T-12: (B)(H)	T-21: (B)(H)	T-30: (B)(H)
T-4: (S)(L)	T-13: (S)(L)	T-22: (S)(L)	T-31: (S)(L)
T-5: (S)(M)	T-14: (S)(M)	T-23: (S)(M)	T-32: (S)(M)
T-6: (S)(H)	T-15: (S)(H)	T-24: (S)(H)	T-33: (S)(H)
T-7: (C)(L)	T-16: (C)(L)	T-25: (C)(L)	T-34: (C)(L)
T-8: (C)(M)	T-17: (C)(M)	T-26: (C)(M)	T-35: (C)(M)
T-9: (C)(H)	T-18: (C)(H)	T-27: (C)(H)	T-36: (C)(H)

Level I

Level II

Level III

Level IV

Level V

EMMA Matrix for Implementation Packages

LAYOUT	TRAFFIC DENSITY	VISIBILITY			
		Vis 1	Vis 2	Vis 3	Vis 4
COMPLEX	Medium	**Implementation Package IP1**	**IP2**	**IP3**	**IP4**
	Heavy	**IP5**	**IP6**	**IP7**	**IP8**

ICAO A-SMGCS Definition

A system providing routing, guidance and surveillance for the control of aircraft and vehicles in order to maintain the declared surface movement rate under all weather conditions within the aerodrome visibility operational level (AVOL) while maintaining the required level of safety.

- **SAFETY**
- **THROUGHPUT (Efficiency)**

EMMA Matrix for Implementation Packages

Traffic Density	Vis 1	Vis 2	Vis 3	Vis 4
Medium optional				
Heavy Optional				

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Logical Interdependencies between EMMA Service Steps

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	Expected Steps to each Service											
Surveillance	**S1** id/pos everything manoeuvering			**S2** Step 1 + id/pos a/c in the movement area						**S3** S2 + id/pos vehicles movement area		
Control	**C1** Conflict Rwy			**C2** Conflict Twy			**C3** Plan / Route Deviation			**C4** Conflict Apron		
Guidance	**G1** Manual switched ground guidance (e.g. Heathrow)									**G2** Auto switch		
Routing				**R1** Manual			**R2** Semi-auto			**R3** Auto (planning)		**R4** ROP
Airborne				**A1** AMM			**A2** Ground traffic + CPDLC			**A3** HUD	**A4** Auto steering	
Vehicles				**V1** AMM			**V2** Ground Traffic			**V3** Data link		

EUROPEAN AIRPORT MOVEMENT MANAGEMENT BY A-SMGCS, Part 2

Proposed Initial Implementation Packages

DLR

Traffic Density	Vis 1	Vis 2	Vis 3	Vis 4
Medium	S1 + C1			
optional				
Heavy				
Optional				

EUROPEAN AIRPORT MOVEMENT MANAGEMENT BY A-SMGCS, Part 2

Proposed Initial Implementation Packages

DLR

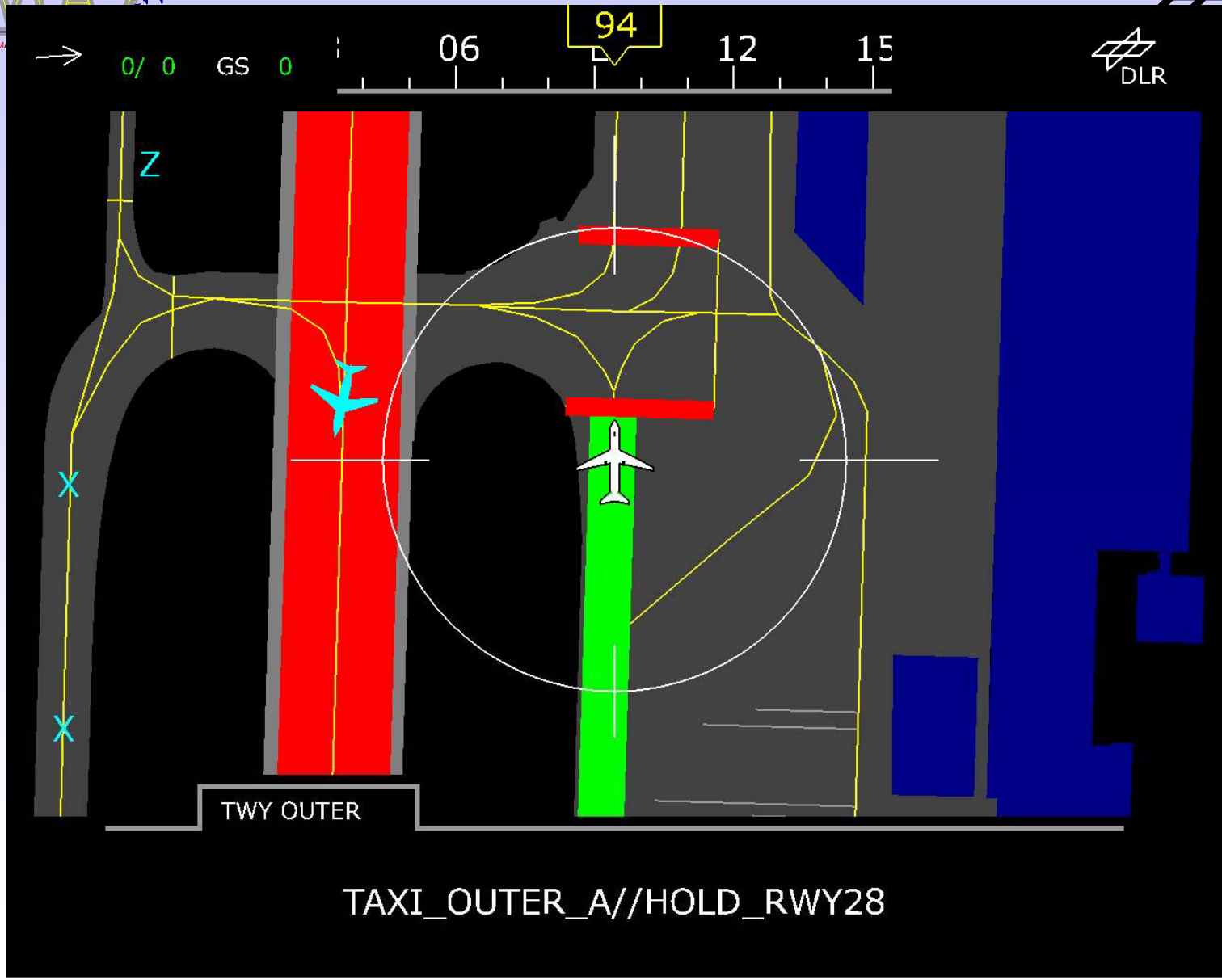
Traffic Density	Vis 1	Vis 2	Vis 3	Vis 4
Medium	S1 + C1	S2 + C1		
optional				
Heavy				
Optional				

EUROPEAN AIRPORT MOVEMENT MANAGEMENT BY A-SMGCS, Part 2

Proposed Initial Implementation Packages

DLR

Traffic Density	Vis 1	Vis 2	Vis 3	Vis 4
Medium	S1 + C1	S2 + C1	S2 + C1 + A2 + V2	
optional				
Heavy				
Optional				

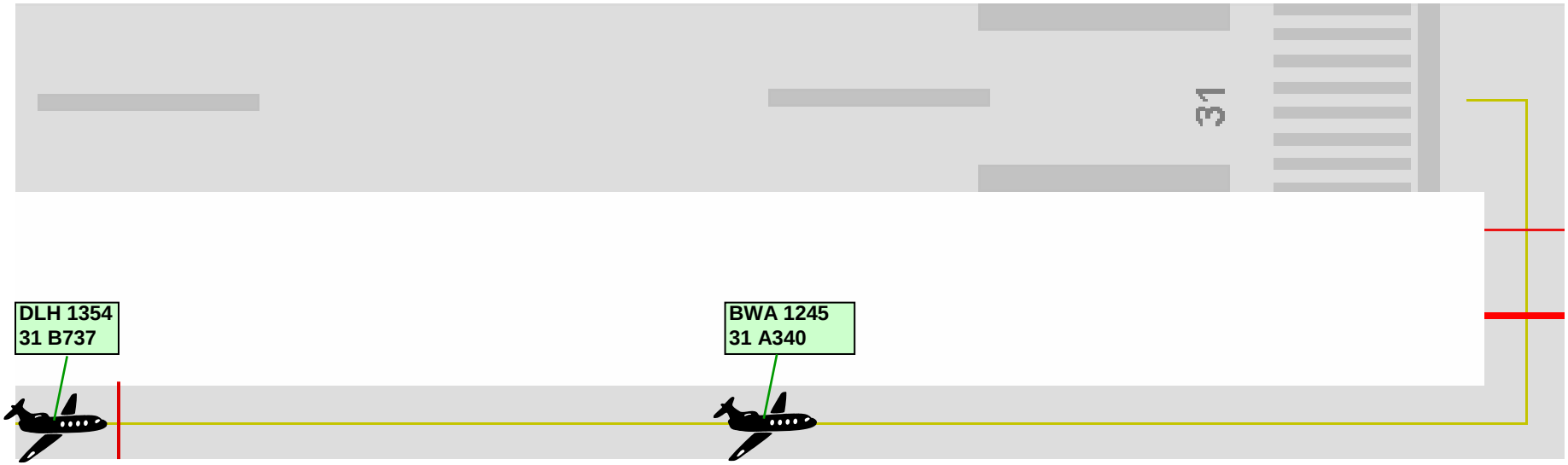

0/ 0
GS 0
06
94
12
15
DLR
Z
X
X
TWY OUTER
TAXI_OUTER_A//HOLD_RWY28

Proposed Initial Implementation Packages

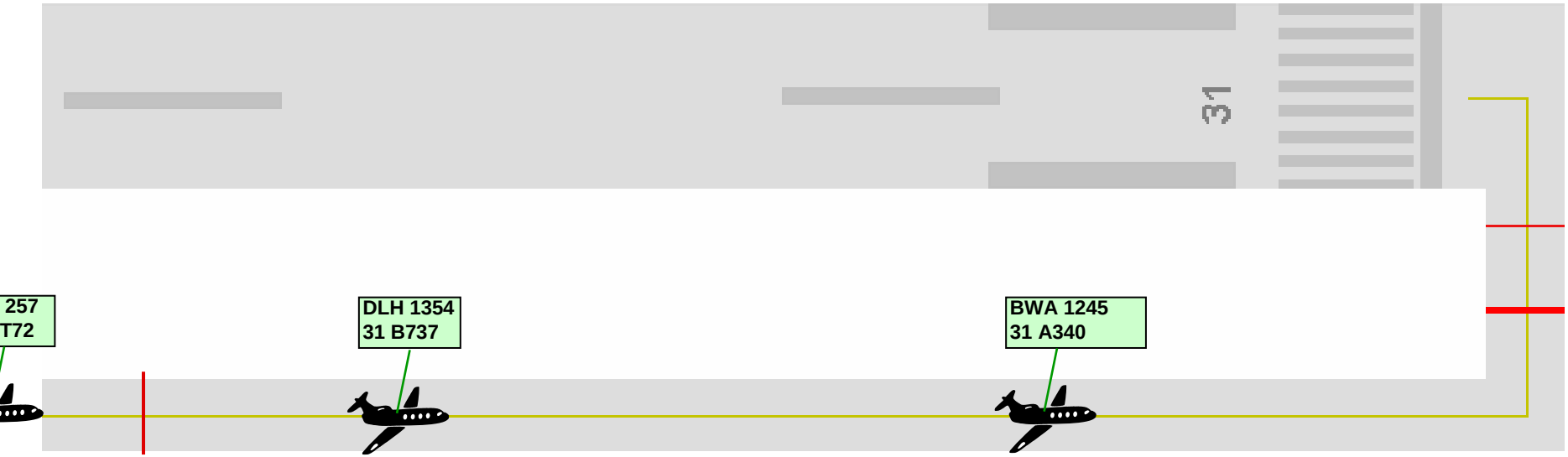
Traffic Density	Vis 1	Vis 2	Vis 3	Vis 4
Medium	S1 + C1	S2 + C1	S2 + C1 + A2 + V2 S3 + C4 + R3	
optional				
Heavy				
Optional				

Seperation in Vis 3

Today

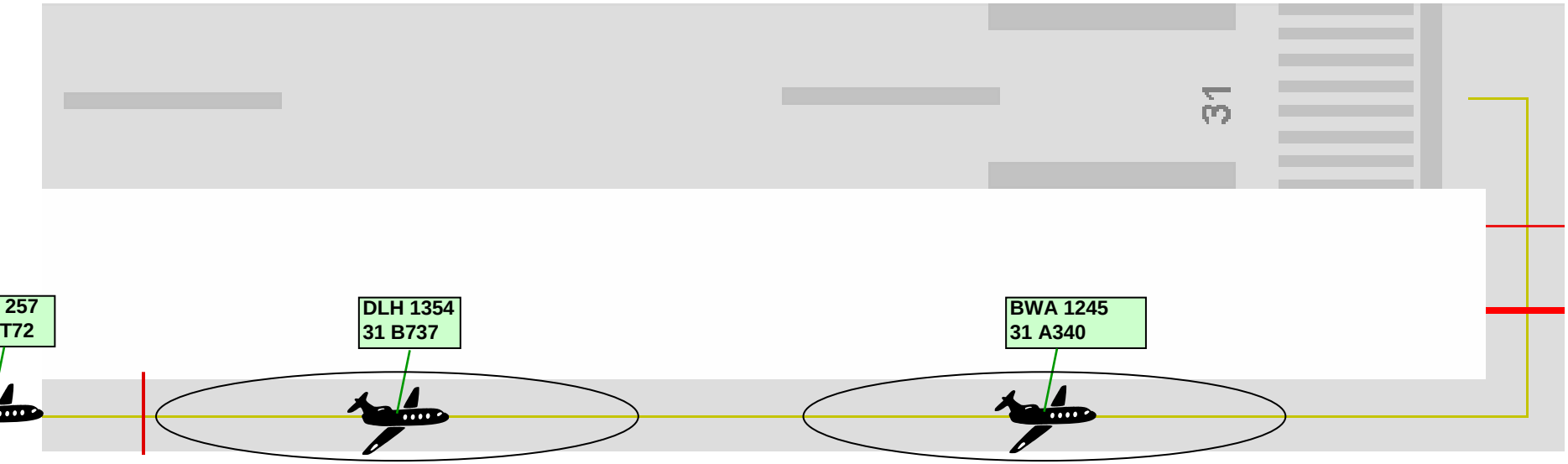


Seperation in Vis 3

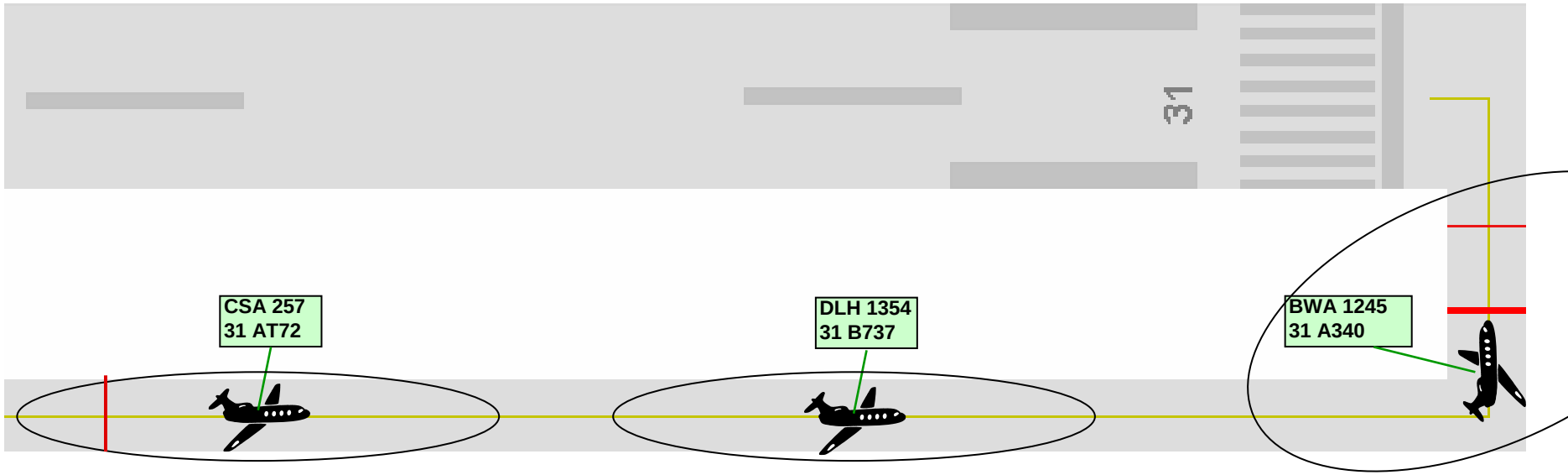


Seperation in Vis 3

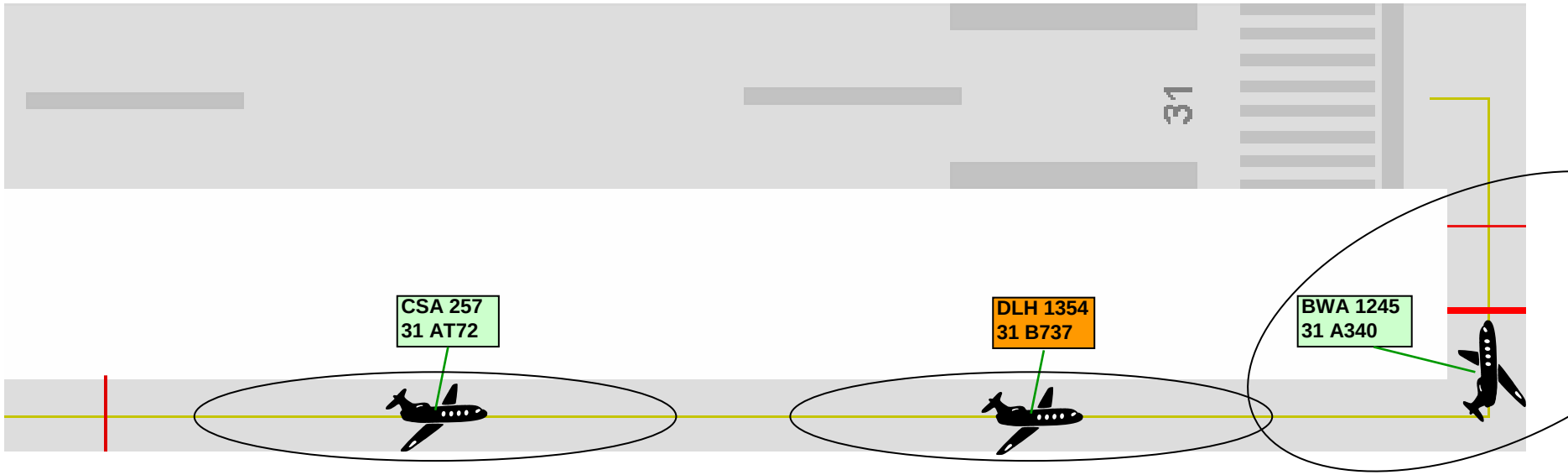
- „Ground STCA“ or
- Aircraft approaching stationary traffic (ICAO doc 9830, §3.4.5.7 b) 2))



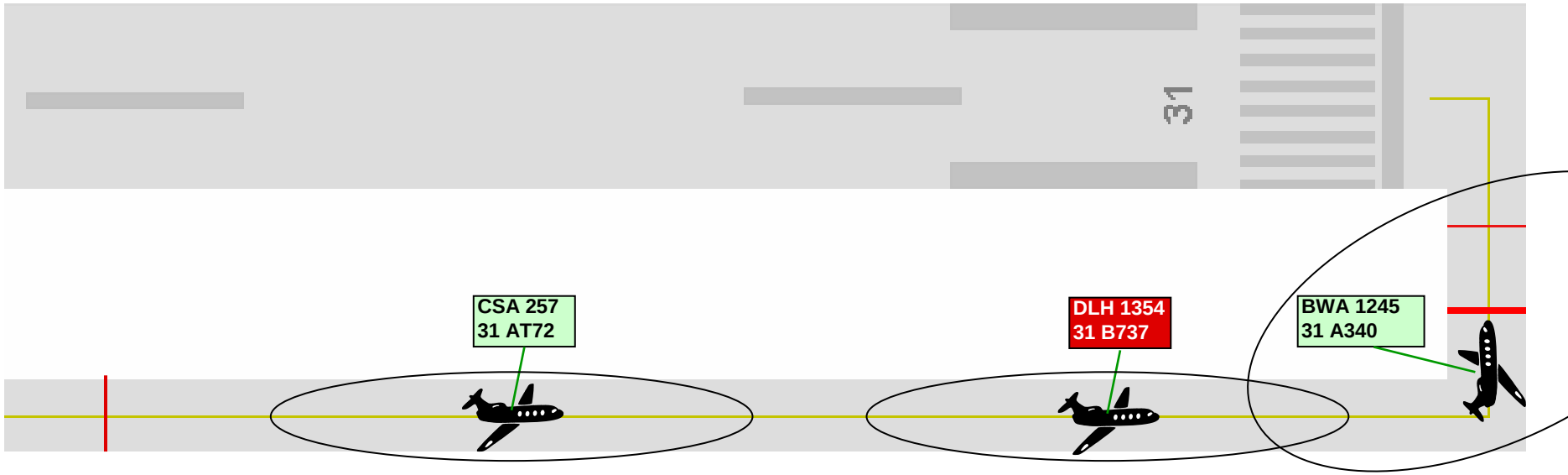
Seperation in Vis 3



Seperation in Vis 3



Seperation in Vis 3



Proposed Initial Implementation Packages

DLR

Traffic Density	Vis 1	Vis 2	Vis 3	Vis 4
Medium	S1 + C1	S2 + C1	S2 + C1 + A2 + V2 S3 + C4 + R3	
optional				
Heavy				
Optional				

Proposed Initial Implementation Packages

Traffic Density	Vis 1	Vis 2	Vis 3	Vis 4
Medium	S1 + C1	S2 + C1	S2 + C1 + A2 + V2 S3 + C4 + R3 S2 + C4+ V2+ R3	
optional				
Heavy				
Optional				

Proposed Initial Implementation Packages

Traffic Density	Vis 1	Vis 2	Vis 3	Vis 4
Medium	S1 + C1	S2 + C1	S2 + C4+ V2+ R3	S2 + C2 + A3 + V2
optional				
Heavy				
Optional				

Proposed Initial Implementation Packages

DLR

Traffic Density	Vis 1	Vis 2	Vis 3	Vis 4
Medium	S1 + C1	S2 + C1	S2 + C4+ V2+ R3	S2 + C2 + A3 + V2
optional	A1 + V1 R3/R4 +A2 +V1	A2 + V2 C2+R3/R4+A2+V1	R4 + A2	C4 + A4 + R3/R4
Heavy				
Optional				

Proposed Initial Implementation Packages

Traffic Density	Vis 1	Vis 2	Vis 3	Vis 4
Medium	S1 + C1	S2 + C1	S2 + C4+ V2+ R3	S2 + C2 + A3 + V2
optional	A1 + V1 R3/R4 +A2 +V1	A2 + V2 C2+R3/R4+A2+V1	R4 + A2	C4 + A4 + R3/R4
Heavy	S2 + C3 + R4	S2 + C3 + R4	S2 + C4 + V2 + R4	S2 + C3 + A3 + V2 + R4
Optional				

EUROPEAN AIRPORT MOVEMENT MANAGEMENT BY A-SMGCS, Part 2

Proposed Initial Implementation Packages

DLR

Traffic Density	Vis 1	Vis 2	Vis 3	Vis 4
Medium	S1 + C1	S2 + C1	S2 + C4+ V2+ R3	S2 + C2 + A3 + V2
optional	A1 + V1 R3/R4 +A2 +V1	A2 + V2 C2+R3/R4+A2+V1	R4 + A2	C4 + A4 + R3/R4
Heavy	S2 + C3 + R4	S2 + C3 + R4	S2 + C4 + V2 + R4	S2 + C3 + A3 + V2 + R4
Optional	A2 + V2	A2 + V2	A2 + V3	A4 + V3

EUROPEAN AIRPORT MOVEMENT MANAGEMENT BY A-SMGCS, Part 2

Proposed Initial Implementation Packages

DLR

Traffic Density	Vis 1	Vis 2	Vis 3	Vis 4
Medium	S1 + C1	S2 + C1	S2 + C4+ V2+ R3	S2 + C2 + A3 + V2
optional	A1 + V1 R3/R4 +A2 +V1	A2 + V2 C2+R3/R4+A2+V1	R4 + A2	C4 + A4 + R3/R4
Heavy	S2 + C3 + R4	S2 + C3 + R4	S2 + C4 + V2 + R4	S2 + C3 + A3 + V2 + R4
Optional	A2 + V2	A2 + V2	A2 + V3	A4 + V3

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Questions…?